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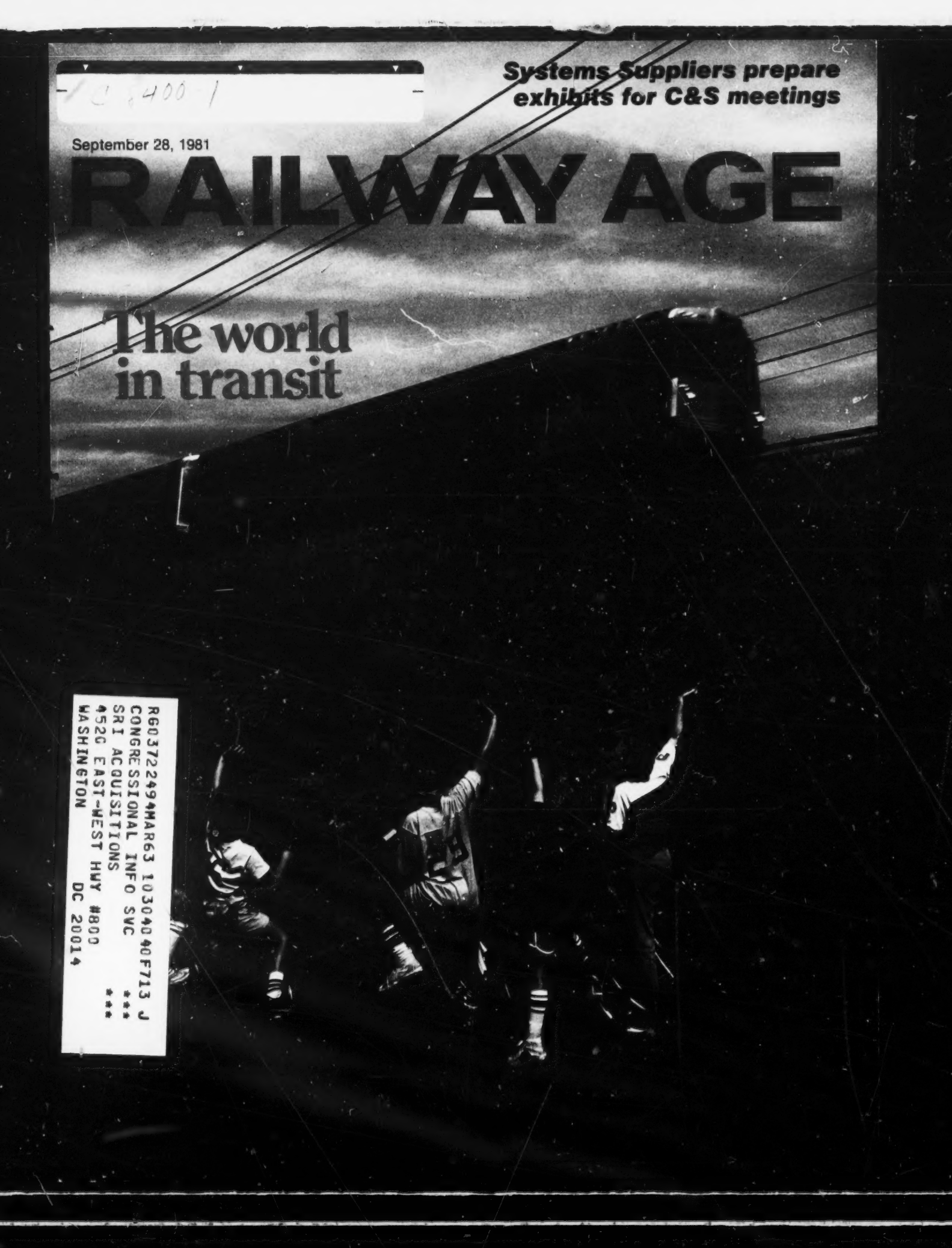
Systems Suppliers prepare exhibits for C&S meetings

September 28, 1981

RAILWAY AGE

The world in transit



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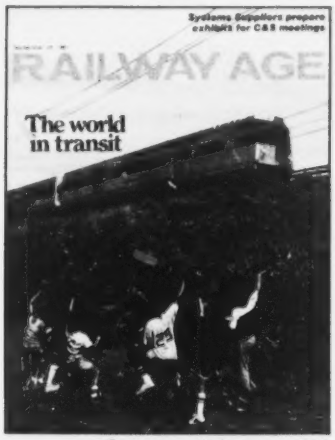
RAILWAY AGE

September 28, 1981

FEATURES



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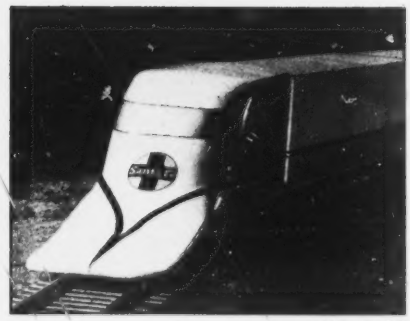

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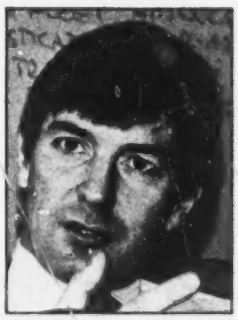

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COVER: PATCO (Lindenwold) line, photographed by Roy H. Blanchard near Collingswood, N.J.

Computers track roadway conditions

When looking at a section of track, you can easily tell whether it has had a long history of good or bad maintenance.

It is not as simple, though, to determine whether an entire Class I railroad is adequately maintaining its track structure. Even though a given railroad might have a history of investing heavily in its track, does a one, two, or three year deferral of some maintenance indicate trouble ahead? How do you measure such a thing—are casualties per million gross ton miles more or less important an indicator than the slow order mileage?

No one has yet come up with the definitive answer to these questions, but the Interstate Commerce Commission has developed a computer program that can give a general picture of a Class I railroad's overall maintenance performance.

David Stephenson, an ICC general engineer, has developed a picture of how individual railroads stack up against other railroads. The program is called MAINTAIN, and its information is available to any interested party.

Stephenson started developing MAINTAIN a little more than one year ago, using information already available through public sources. The program's data base was culled mostly from annual reports filed with the ICC by Class I roads. From this information, Stephenson developed 15 indicators of track maintenance trends, and Ira Winthrop, another ICC general engineer, wrote a computer program that presents a host of comparisons between the indicators.

Railroads and the Federal Railroad Administration have expressed great interest in the program. "Some of the ratios were similar to others they had seen, but no one had seen all the information gathered together for comparison in this manner," says Stephenson.

Stephenson stresses that no matter how many adjustments are made in MAINTAIN, it has certain limitations. "This isn't an answer," he says, "it's just a tool for analysts to decide whether to go further."

As such, it appears to be extremely useful. In the accompanying table, the 15 indicators are listed for railroad track maintenance programs in 1978 and 1980, the period now tracked by MAINTAIN. As data from future years are added, trends will become easier to spot, but it is clear that overall industry track maintenance improved during the three years.

The overall indicator relates speed to traffic density. It is not composed of the 14 other indicators as its name might suggest and, indeed, no summary or weighted average can be drawn from MAINTAIN. The overall indicator is based on an open ended scale in which higher numbers indicate improved performance.

In many of the other categories listed, industry performance improved. Casualty costs per mile, slow order mileage ratios, and surface cycle times all were down. Total roadway maintenance costs increased (perhaps due largely to inflation) but the cost per operating expense dollar fell slightly. Oddly, tie and rail replacement cycle times increased slightly from 1978 to 1980, due perhaps to recessionary pressures on the industry.

Do these averages accurately reflect nationwide performance? Take a look at two railroads in 1978 to see whether their known performance is properly reflected in the figures. One railroad, "A" is among the most prosperous and is an acknowledged leader in track maintenance. The other railroad, "B", is a weak character that lacks the resources of A.

By giving the MAINTAIN computer a few simple instructions, Stephenson is able to call up a summary of performance indicators for A and B, as well as a comparison to the national average. Generally, the results seem accurate. The computer finds railroad B deficient in 13 of the 15 indicators. Railroad A, on the other hand, doesn't fail a single test. The overall indicator for A is 308 (very high) and B limps in at 184. As railroad B embarked on a track improvement program during 1979 and 1980, its performance was accurately followed by MAINTAIN.

It is through such specific comparisons of MAINTAIN to reality that Stephenson is gaining confidence that he has designed at least a good starting point for the development of a reliable tool that railroad managers and others can use when assessing their performance.

There are problems to be solved, as Stephenson illustrates with the results MAINTAIN shows for one successful railroad that has a high percentage of terminal track. "This railroad runs a pretty tight ship," says Stephenson, "but they received a low overall rating in this program. After studying the results for a while, it became apparent that their large amounts of terminal track skewed the results. So it's important when looking at this that you take into account the various things that can affect the outcome."

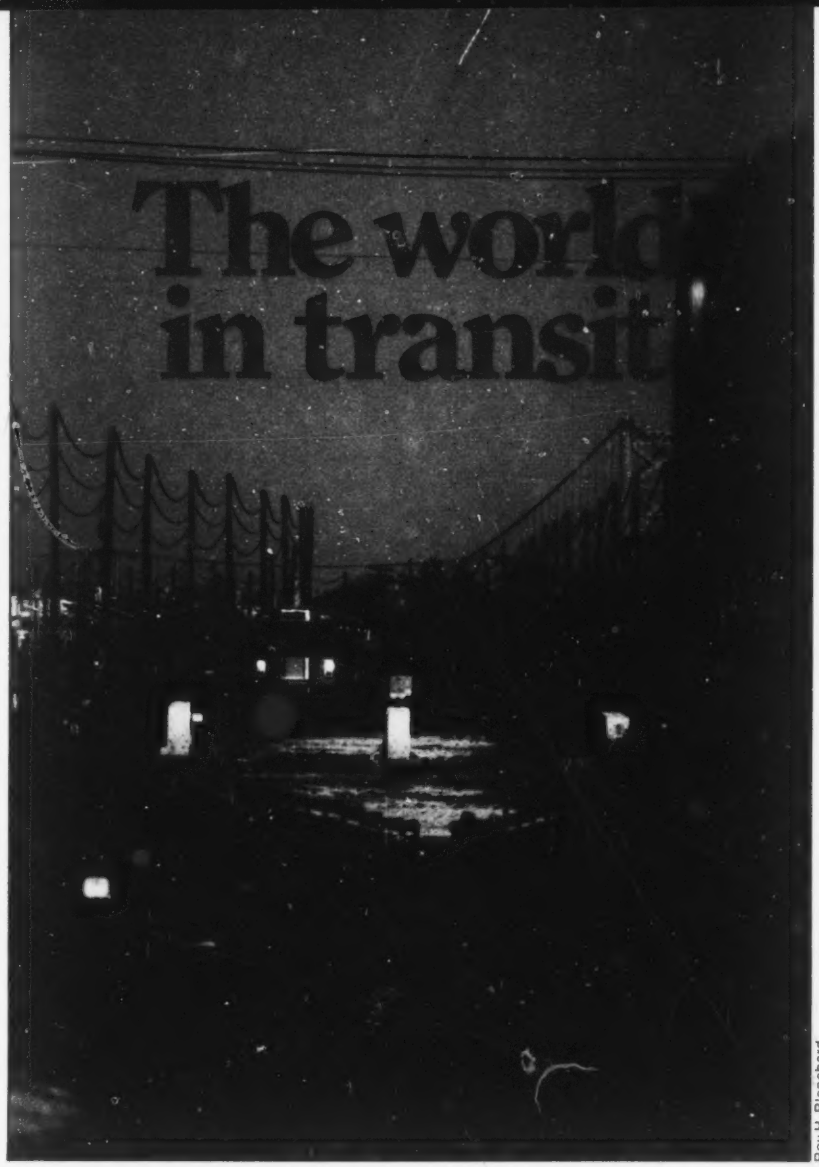
Stephenson is constantly looking for such anomalies—and for ways to correct them. That is why he is anxious to hear the reaction of others who may be more familiar with specific problems in MAINTAIN. Once these are worked out, Stephenson expects to have a good barometer of U.S. track maintenance practices, something he says, "You could put in front of somebody that would give them an overview fairly fast." ■

Fifteen MAINTAIN Indicators

	1978	1980
Overall Indicator (relates speed to traffic density lower number indicates low performance)	250	259
Tie Replacement Cycle (Years)	31.9	32.6
Tie Replacement Cycle (3 year average)	37.8[1]	32.2[2]
Rail Replacement Cycle (Years)	35.7	36.1
Rail Replacement Cycle (3 year average)	38.0[1]	34.7[2]
Ballast (cubic yards/mile)	85.0	98.0
Slow Order Mileage Ratio (percentage)	11.3	10.4
Surfacing Cycle (years)	5.5	4.2
Total Roadway Maintenance Cost per Track Mile	$8055	$9941
Maintenance Cost per Operating Expense Dollar	10.9¢	10.4¢
Total Roadway Maintenance Cost/Track Investment Dollar	22¢	26¢
Material Installed per Labor Dollar	93¢	$1.02
Operating Expense per Million Gross Ton Miles (MGTM)	$10,128	$12,182
Total Roadway Maintenance Cost per MGTM	$1,101	$1,268
Casualty Cost per MGTM	$258.32	$248.83

[1]Average of figures reported in 1976, 1977 and 1978
[2]Average of figures reported in 1978, 1979 and 1980

The world in transit



Roy H Blanchard

Cities all over the globe are increasingly turning to the metropolitan railway as the answer to a host of urban problems. But the actions (and non-actions) of the Reagan Administration are raising troubling questions about the future of rail transit in the U.S.

By ALBRECHT P. ENGEL, Manager, Planning & Development Transportation and Transmission, Gibbs & Hill, and FREMONT FELIX, Consultant, Gibbs & Hill

While many rail transit professionals make last minute preparations for participation in the much heralded Public Transit Expo 81, their thoughts must turn to the gnawing question of what the future holds. In contrast to the shadow cast over rail transit today by our national leadership, the atmosphere pervading the industry when the Expo 81 idea was born, more than two years ago, was one of considerable optimism. The expanding role of rail mass transit as an integral element in this nation's ground transportation system seemed assured. The unprecedented appearance of the President of the United States at the 1979 APTA conference in New York and his proclamation of the energy implications of mass transit was considered a capstone of the industry's long drive for recognition at the highest level. This in itself was quite an achievement for an industry that, only two years earlier, had been totally overlooked as an energy conservation alternative in that Administration's proposed energy bill.

With policy and priority seemingly well established at the close of the turbulent 70's, what appeared to lie ahead for rail transit in the 80's was a streamlining of administrative matters related to the federal funding process and the implementation of a rigorous set of technical guidelines to encourage a greater measure of industry standardization. What could be a better forum to exchange views on these issues than an international transit exposition early in the decade? Unfortunately, the deemphasis on rail transit by the current Administration has forced a modified agenda. Beyond the technical and administrative issues, public transportation leaders will be looking for new approaches to strengthen the case for an enduring rail transit culture in the U.S.

The task is a challenging one, because the transit industry is operating in somewhat of a vacuum as to what, in fact, the national transportation policy is. Can we glean any insight from Transportation Secretary Drew Lewis's opening remarks at the May 1981 DOT International Symposium on Surface Transportation System Performance? He said, "We expect the costs of most transportation service to be met by the users. Our job is not to prop up inefficient systems through endless subsidies but to focus federal funds on those high payoff areas where wise capital investments will result in better performance."

One can't help but wonder how the Washington Metro funding application would have been received under this "policy." There are critics who claim (with very few well-founded arguments) that the system is too costly. Yet how many residents, or regular business travelers to the city, would be willing to live without the rail transit system? Those familiar with Washington will recall the automobile traffic congestion prior to the inauguration of service. It's difficult to imagine a more practical solution than a heavy rail system; yet, we have not seen any encouragement coming from the new Administration on new rail starts.

To be sure, the objectives of improved system efficiency, better performance, high payoff focus, and wise capital investments are most appropriate and certainly congruent with industry objectives. But one has to question the equity of burdening the transportation user with the full cost of the service, whether on an

Number of metros in operation or in construction 1980

	Operation	Construction	Design/ Planning
Argentina	1[1]		
Australia	1		
Austria	2[2]		
Belgium	1[1]		
Brazil	2[1]		
Bulgaria		1	
Canada	2[2]		
Chile	1[1]		
China	2[2]		
Czechoslovakia	1[1]		
Denmark	1		
Ecuador			1
Finland		1	
France	4[3]	1	
East Germany	1[1]		
West Germany	6[4]		
Greece	1		
Hong Kong	1[1]		
Hungary	2[1]		
India		1	
Iraq		1	
Ireland			1
Israel			1
Italy	2[2]	1	
Japan	9[5]		
Korea, Rep. of	1[1]		
Mexico	1		
Netherlands	2[1]		
Norway	1[1]		
Peru			1
Poland		1	
Portugal	1[1]		
Rumania	1		
Spain	3[1]	1	1
Sweden	1[1]		
Taiwan			1
Turkey			1
United Kingdom	3[6]		
United States	10[4]	3	2
U.S.S.R.	7[1]	4	3
Venezuela		1	
	71[7]	16	12

Footnotes:
1 System(s) being expanded
2 Only one of these systems is being expanded
3 Three systems are being expanded
4 Four systems are being expanded
5 Eight systems are being expanded
6 Two systems are being expanded
7 Fifty-one systems are being expanded

individual or broader regional basis. This is somewhat reminiscent of the childless couple's argument for exemption from school taxes.

The beneficiaries of rail transit include not only the direct users but non-users as well. What's wrong, for example, with having the diehard automobile commuter who is enjoying the reduced traffic congestion on a favorite freeway participate in the cost of the rail transit system that helped facilitate the continuation of an automotive addiction? The cost/benefit issues surrounding public transportation are enormously complex; the transit industry's leadership has been hard at work for some time developing well thought out policy recommendations which take into consideration the diverse implications. Any departure from a maturing rail transit policy should be made with no less forethought.

It appears that, for the immediate future, rail transit has become nothing more than a budget line item targeted for heavy pruning to achieve a general federal expenditure reduction. Who can argue that the drive to improve the general economic condition of the U.S. is not a matter of the utmost urgency? It is for just this reason that rail transit cannot be arbitrarily grouped with a host of questionable "Great Society" programs scheduled for budget reductions. On the contrary, rail transit must be given a high priority since sound and efficient transportation is at the very heart of any healthy society and economy.

Defusing the rail transit movement, which has been gathering momentum since the landmark 1964 mass transit legislation and the introduction of the highly successful Lindenwold line in 1969, will undoubtedly have some significant adverse long term economic impacts. Although the philosophical position that responsibility for mass transit resides at the local level may be sound, the practical realities are another matter. The financing structure for rail transit has evolved over a period of several decades; it involves a federal, state, and local funding partnership along with a substantial revenue component, unlike other public services, contributed by the users. That structure cannot be changed overnight on a unilateral basis without creating confusion, a deferral of important projects, and, ultimately, an increase in costs to the consumer once all the pieces are again aligned.

As the U.S. continues to sort out its priorities and perhaps draft a more meaningful public transit policy, the trend toward greater utilization of metropolitan railways—or metros—is unmistakable, certainly when viewed from an international perspective.

After a fairly constant rate of new construction—two systems every five years between 1907 and 1935—the pace of new projects stepped up sixfold after World War II into a trend of 12 new metros placed in operation every five years. This accelerated rate was motivated by the need to relieve the traffic congestion of inner cities—an important part of the fight against the twin enemies of air pollution and urban blight.

Even with reserved lanes for buses, it takes a high-speed, high-volume rapid transit system, operating on its own right-of-way, to take the strain off streets and freeways. It has been calculated that if the Bay Area Rapid Transit (BART) system, which carries 165,000 passengers a day, did not exist, 3,300 additional buses or 137,500 additional automobile trips would be required.

Cities around the world appear to have learned this lesson.

Of the 71 existing metro systems around the world, which now have 2,079 route miles in operation, 51 are expanding: they are constructing 475 additional route miles and have 995 more miles in the planning stages.

The eventual total length of these systems will be 3,538 miles. Sixteen new systems now under construction will total 270 miles. Twelve other systems totaling 155 miles are in the design or planning stages.

How big does a city or metropolitan area have to be to "qualify" for a metro? A population of 1 million has generally been regarded as a suitable threshold,

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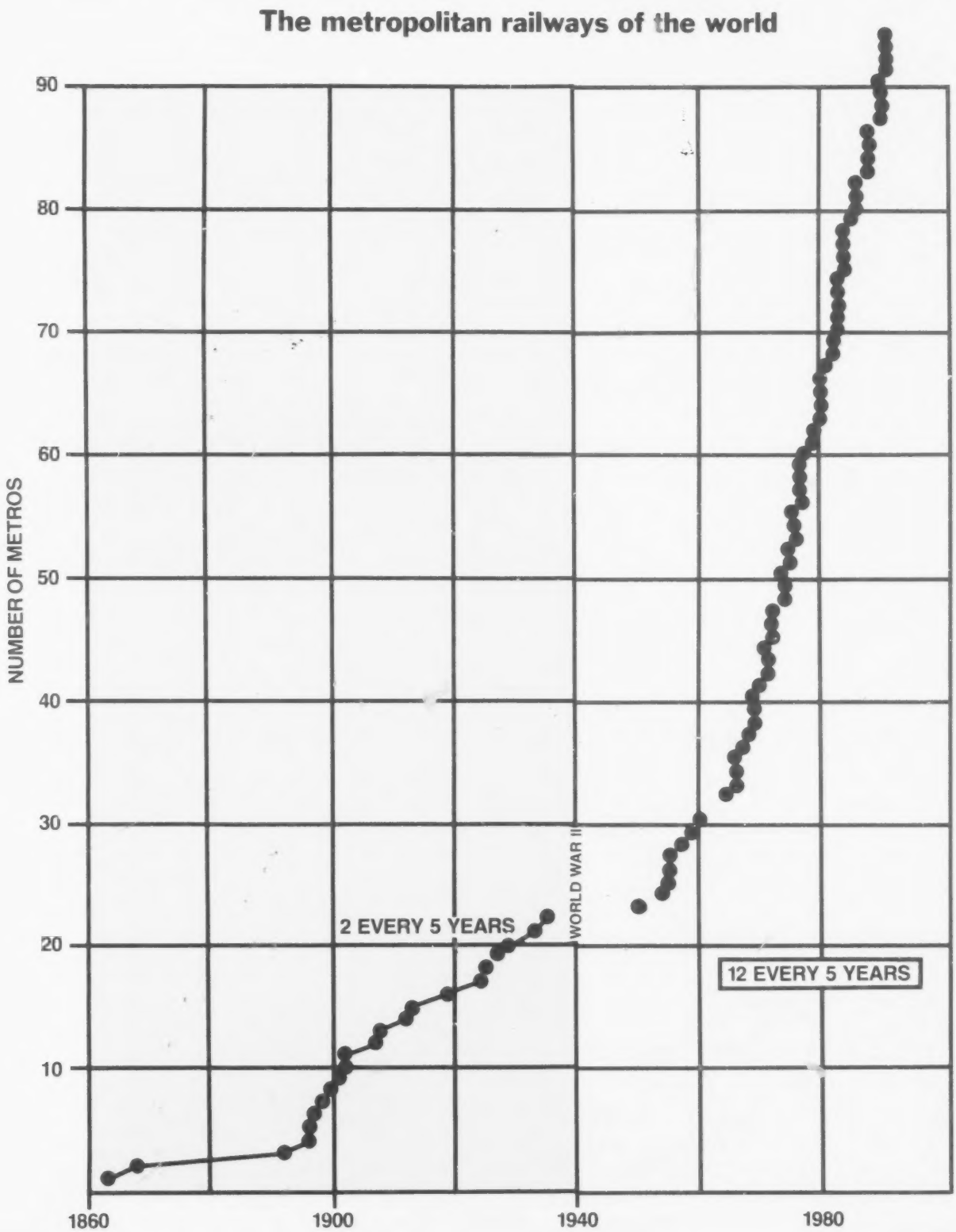
The metropolitan railways of the world
NUMBER OF METROS
90
80
70
60
50
40
30
20
10
1860
1900
1940
1980
WORLD WAR II
2 EVERY 5 YEARS
12 EVERY 5 YEARS

but there are other important considerations.

Starting with Oslo in 1966, more than half of the urban areas building or planning metros have been in the 500,000 to 1.5 million population range. Eleven of these have less than 1 million population. They have been motivated by a number of reasons: enhancing the quality of urban life, improving accessibility to work, and, not least, bolstering the local economy, through both the employment generated by multi-million dollar construction efforts and the resulting spur to business and area development.

The escalating number of new metros throughout the world reflects the awareness that, starting from a certain stage of development, the large city becomes the victim of the pole of attraction that it constitutes. Thus, unless revitalized by the rapid transit lifeline, transportation will become a major problem, threatening the economic viability of central cities.

In the U.S., too, where in an entire century only six rail transit systems were placed in operation, there have been since 1972 six new systems inaugurated or placed under construction. Several more are planned.

Global comparison of major metros

	Global Average	New York	Paris Metro	Paris RER	Moscow	Tokyo TRTA	Tokyo TBTMG
Average Passengers per car	40.9	38.3	28.8	45.3	54.5	72.3	45.3
Car Capacity	185	350	164	253	170	144	160
Average Occupancy as % of Capacity	27.4	11.0	17.6	17.9	32.0	50.2	28.3
Sq. ft per Passenger		2.1	2.3	3.0	3.1	4.0	3.4
KwHrs per Car Mile	5.90	5.84	4.46	6.40	3.97	3.77	4.92
Hours service is provided	–	24	20.25	20.25	19	19.50	19.50

Note: Of the 6 major systems shown in Table III, the New York subway is the only one which operates 24 hours every day. In fact, of all the other "metros" in the world, only the Chicago, Cleveland and Philadelphia systems also provide round-the-clock service. This is mentioned because it results in a lower average occupancy for the New York subway train than would be the case if operation was only provided 19 or 20 hours a day.

Certain advantages of rail transit are obvious and well known: comfort, convenience, reliability, safety, high potential passenger capacity (between 40,000 and 70,000 riders per hour).

In addition to reduced door to door travel time, rapid transit offers other, less obvious benefits to the community. It has been demonstrated to be a major tool of controlled urban development. Retail sales soar in the immediate impact area (which is estimated at one square mile surrounding each station). Shopping malls spring up. There is a catalytic effect on major commercial or residential development. All of this inhances the quality of life.

There are, indeed, few city planners who would dispute that, even in an era of persistent budget deficits, money spent on rail transit would not pay off handsomely, stimulating the economy through higher productivity and increased retail sales. Their big question is: "Can we afford it?"

It is true that initial construction costs can be high, but operating costs are much less inflation sensitive. The cost of operating buses (and, of course, automobiles) is likely to escalate more rapidly, due both to increases in the price of fuel and to the labor intensive nature of the operations. There remains, of course, a need for the flexibility of the bus mode in low patronage applications.

In this era of energy consciousness, some foes of heavy rail transit thought that they had found a telling argument by "calculating" that the energy expended in the construction of a new rail system created an "energy debt" that would take up to 535 years of energy saving in operations to recoup. This is a distorted and misleading argument.

The San Francisco/Oakland BART system required 38.3 trillion Btu of energy for its construction, whereas the construction of a highway system as an alternative to BART would have required 79.6 trillion Btu.

As for traction, both heavy rail transit and buses use the same amount of primary energy per passenger mile—the equivalent, say, of 1/100th of a gallon, which is the same as getting 100 miles per gallon. (During crush hours, passenger miles per gallon grow to 540.) However, in the case of buses, we are talking real gallons and barrels of oil. Taking into account the indirect costs of purchases from overseas (loss of jobs in the U.S., effect on the balance of payments, inflation, the cost of insuring some immunity from interruptions through strategic reserves, etc.), the cost of a $36 imported barrel doubles to $72 as far as the U.S. economy is concerned. In the case of a metro, we are talking mainly of electric energy, obtained from hydro or nuclear power or coal, which has an equivalent "electric barrel" of oil cost as low as $16.

With bus energy costing up to two to four times as much as metro energy, on which side is the energy debt?

Life expectancy is another important consideration. Whereas most plants and machinery and other capital installations have life expectancies of 30 years or so, all metros that have ever been constructed—and some of them are now more than 100 years old—are not only still operating but are fulfilling a function which could not be matched by any substitute. Paris, which already had an extensive and highly serviceable 80-year-old metropolitan system, found it necessary to add, 12 years ago, a new regional express line (RER), which crosses the city from the eastern suburbs to the western suburbs, creating an artery which looked far into the next century for its reason of being. It had to be built 100 feet or more below surface, and its construction created major traffic tieups for several years—but these inconveniences have long been forgotten in the realization of the benefits the new system is bringing.

The economic value of metro transportation can hardly be overestimated. The scheduled speed for New York subway riders averages between 20 and 30 mph, compared with 6 to 8 mph speeds for the buses. For the more than 1 billion passengers who use the New York subways annually and for whom the average length of trip is nine miles, this represents, without counting frayed nerves, a total saving of 1 billion hours; even at the minimum wage, that translates into a saving of $3 billion a year to the economy of New York City.

The case for rail transit is a strong one. It cannot, in good conscience, fail to be recognized by an Administration dedicated to a return to sound business principles and to increased national productivity.

The metropolitan railways of the world: Statistical highlights

No.	Year of Initial Operation	City	Million Population	ROUTE MILES: In Operation: Total	In Operation: Above Ground	In Construction	In Design Planning	Avge. Distance Between Stations	Speed MPH: Maximum Design	Speed MPH: Avge. Commercial	Annual Million Passengers	Avge. Trip Length	Annual Million Passenger Miles	No. of Cars	Annual Million Car Miles	Avge. Passengers Per Car	Passenger Capacity: Latest Cars: Total	Passenger Capacity: Latest Cars: Seated	Car Floor Area, sq. ft	Annual Million kWh for Traction	kWh Per Car Mile	Power Supply: Voltage	Power Supply: 3rd R. or Cat.
		NORTH AMERICA																					
		Canada																					
1.	1966	Montreal	2.7 (A)	25.7	(0.0)		5.1	0.56	43.5	22.4	142.1	4.10	582.9	735	33.5	17.4	160	40	441	251.9	7.52	750 V	2. G.B.
2.	1954	Toronto	2.1 (A)	32.8	(5.0)		0.9	0.47	52.2	18-23	204.4	4.29	875.7	632	37.7	23.2	319	76	732	326.0	8.65	600 V	3rd R.
		Mexico																					
3.	1969	Mexico City	13.0 (A)	28.8	(8.0)		22.4	0.54	50.0	21.6	837.5	4.72	3955.8	882	55.1	71.8	170	99	441	358.4	6.50	750 V	2. G.B.
		United States								30.0				120			275	65	753				
4.	1979	Atlanta	1.7 (A)	11.8	(5.0)	4.4	9.6	0.99	70.0	30.0	25 est.			72			154	74	687			750 V	3rd R.
5.	1982	Baltimore	2.5 (A)			8.0	5.6	1.00	70.0													700 V	3rd R.
6.	1897	Boston	2.8 (A)	34.2	(21.1)	6.4	9.1	0.68	44.7	17-24	95.0			339	11.1		239	64	639	66.0	5.95	600 V	3rd R.
7.	1984	Buffalo	1.3 (A)			6.9			55								200	60	608				
8.	1892	Chicago	6.7 (A)	89.0	(79.0)	7.5		0.62	55-70	24-28	150.7	5.1	769	1102	49.65	15.9	150	49	427	247.3	4.98	600 V	3rd R.
9.	1955	Cleveland	2.0 (A)	19.0	(18.7)			1.11	60.0	30.0	10.7			116	3.5		140	80	705	30.8	8.80	600 V	Cat.
10.	1990	Houston	2.4 (A)				11.0																
11.	1990	Los Angeles	9.5 (A)				18.0		80.0								150	72	813				
12.	1984	Miami	1.5 (A)			20.5		1.06	70					136			160	80	718				
13.	1868(A)	New York (NYCTA)	17.2 (A)	230.6	(93.6)			0.50	55.0	30-19	1054.2	9.0	9507	6424	248.5	38.3	350	76	715	1450.3	5.84	650 V	3rd R.
14.	1908	New York (PATH)	6.3 (A)	13.9	(6.0)		18.0	1.31	55	21.4	44.3	4.5	198	291	9.20	21.5	155	35	459	65.8	7.15	650 V	3rd R.
15.	1907	Philadelphia (SEPTA)	4.0 (A)	24.4	(8.6)		6.2	0.50	50	18-25	63.3	4.3/ 6.0	326	461	13.1	25.7	250/ 145	67/ 56	657/ 478	121.9	9.31	600 V	3rd R.
16.	1969	Philadelphia (PATCO)	4.0 (A)	14.5	(11.6)		32.6	1.21	74.6													800 V	3rd R.
17.	1972	San Francisco	3.1 (A)	71.5	(51.9)		53.1	2.30	80.0	43.5	44.6 (1978)	12.43	554.4	450	26.81	20.7	222	72	759	174.1	6.5	1000 V	3rd R.
18.	1976	Washington	3.1 (A)	33.7	(14.9)	28.0	38.3	0.93	75.0	35.0	59.2			300			232	68	721			750 V	3rd R.
		SOUTH AMERICA																					
		Argentina																					
19.	1913	Buenos Aires	8.9 (A)	21.1	(0.0)	6.3	34.1	0.37	43.5	11-16	207.0	2.5	528	414	14.2	36.5	167	47	585	54.8	3.86	550 V 1100 V 1500 V	3rd R. Cat. Cat.
		Brazil																					
20.	1977	Rio de Janeiro	9.0 (A)	3.2	(0.0)	10.0	29.2	0.62	62.2	28.0	7.0						368	44	656			750 V	3rd R.
21.	1974	Sao Paulo	12.4 (A)	12.4	(3.1)	15.7	27.8	0.56	62.1	18.6	197.7	4.35	860.0	228	14.2	60.7	330	62	646	79.1	5.6	750 V	3rd R.

(Continued)

The metropolitan railways of the world: Statistical highlights

No.	Year of Initial Operation	City	Million Population	ROUTE MILES: In Operation: Total	ROUTE MILES: In Operation: Above Ground	ROUTE MILES: In Construction	ROUTE MILES: In Design Planning	Avge. Distance Betw. Stations	Speed MPH: Maximum Design	Speed MPH: Avge. Commercial	Annual Million Passengers	Avge. Trip Length	Annual Million Passenger Miles	No. of Cars	Annual Million Car Miles	Avge. Passengers Per Car	Passenger Capacity: Latest Cars: Total	Passenger Capacity: Latest Cars: Seated	Car Floor Area, sq. ft	Annual Million kWh for Traction	kWh Per Car Mile	Power Supply: Voltage	Power Supply: 3rd R. or Cat.
		Chile																					
22.	1975	Santiago	4.2 (A)	12.7	(4.1)	3.0	3.0	0.45	43.5	20.0	95.0	3.10	294.5	196			169	38	447	48.0		750 V	2. G.B.
		Ecuador																					
23.	1990	Quito	0.6 (A)				10.0	0.88	62.2					120			300	48	521				
		Peru																					
24.	1990	Lima-Callao	3.3 (A)				15.5	0.62	56.0	23.0							250	68					
		Venezuela																					
25.	1983	Caracas	2.2 (A)			12.3	9.3	0.60	50.0	21.1				242			240	57	638			750 V	3rd R.
		EUROPE																					
		Austria																					
26.	1898	Vienna (Stadtbahn)	2.0 (A)	12.8				0.62	24.9	15.2	54.4	3.4	183	310	11.62	15.8	100	20	274	16.0	1.38	750 V	Cat.
27.	1976	Vienna (U-Bahn)	2.0 (A)	7.9	(0.9)	8.2	2.5	0.58	50.0	22.0	34.0			212	1.49		140	49	533	16.4	11.0	750 V	3rd R.
		Belgium																					
28.	1976	Brussels	1.2 (A)	7.3	(1.9)	8.1	1.2	0.38	45.0	18.1	35.6			90	2.73		210	40	511	41.3	12.1	750 V	3rd R.
		Bulgaria																					
29.	1986	Sofia	1.1 (A)			4.7	64.9	0.78	50					125			220	42	533			600 V	3rd R.
		Czechoslovakia																					
30.	1974	Prague	1.2 (C)	7.0	(0.3)	5.0	33.8	0.53	56.0	20.5	207.4						162	42	516			750 V	3rd R.
		Denmark																					
31.	1935	Copenhagen	1.8 (A)	0.9			2.8		56.0		87.2			241			120	65	561				
		Finland																					
32.	1982	Helsinki	0.8 (A)			7.0	16.7	0.87	56.0	26.7				90			200	67	710			750 V	3rd R.
		France																					
33.	1983	Lille	1.0 (A)			7.9		0.50	50.0	21.7				152			80	22+ 12js	233			750 V	2. G.B.
34.	1978	Lyons	1.1 (A)	7.3	(0.0)	1.5	19.1	0.42	56.0	18.0	42.1	1.74	73.3	66	2.61	28.1	126	56	530	14.0	5.4	750 V	2. G.B.
35.	1977	Marseilles	1.0 (C)	5.6	(1.9)		5.6	0.50	50.0	20.5	26.5	2.36	62.6	63	2.42	25.9	120	48	436	18.0	7.4	750 V	2. G.B.
36.	1900	Paris (Metro)	8.6 (A)	117.2	(9.3)	5.3		0.34	43.5	14.7	1107.1	3.0	3372	3496	117.2	28.8	164	22 +24js	379	522.7	4.46	750 V	3rd R.
37.	1969	Paris (RER)	8.6 (A)	57.3	(40.7)	7.0		1.28/ 0.79	59-50	30-25	196.2	8.84	1341.3	506	29.6	45.3	253	78+ 40js	748	189.3	6.40	1500 V	Cat.

(Continued)

The metropolitan railways of the world: Statistical highlights

No.	Year of Initial Operation	City	Million Population	ROUTE MILES: In Operation: Total	In Operation: Above Ground	In Construction	In Design Planning	Avge. Distance Betw. Stations	Speed MPH: Maximum Design	Speed MPH: Avge. Commercial	Annual Million Passenger Miles	Avge. Trip Length	Annual Million Passenger Miles	No. of Cars	Annual Million Car Miles	Avge. Passengers Per Car	Passenger Capacity: Latest Total	Passenger Capacity: Cars Seated	Car Floor Area, sq. ft	Annual Million kWh for Traction	kWh Per Car Mile	Power Supply: Voltage	Power Supply: 3rd R. or Cat.
		Germany Democratic Republic																					
38.	1902	East Berlin	1.6 (A)	10.0	(1.4)	4.0	22.7	0.48	43.5	15-20	75.0			340	6.96		110	33	288	17-28	2.4-4.0	750 V	3rd R.
		Germany Federal Republic																					
39.	1902	West Berlin	2.0 (C)	59.7	(10.9)	6.0	5.2	0.48	43.5	19.5	325.0	3.9	1252	914	41.6	30.1	197	38	427	155.3	3.73	750 V	3rd R.
40.	1968	Frankfurt	1.2 (A)	5.3		12.4		0.50	50.0	19.5	32.3	2.86	92.4	116			242	62	694				
41.	1912	Hamburg	2.5 (A)	55.6	(35.7)			0.66	43.5	19.6	180.2	3.3	594	849	31.6	18.8	364	92	1120	87.4	2.77	750 V	3rd R.
42.	1971	Munich	1.8 (A)	9.9	(1.8)	8.9	7.5	0.53	50	21	101.4	2.24	226.9	250	6.8	33.2	145	49	527	55.0	8.09	750 V	3rd R.
43.	1972	Nuremberg	0.8 (A)	5.8	(1.8)	2.1	5.9	0.45	50.0	20.0	25.0			64	6.21		145	49	566	61.0	9.8	750 V	3rd R.
44.	1901	Wuppertal	0.6 (A)	8.3	(8.3)			0.38	37.3	16.4	17.0	2.8	48	58	1.00	48.0	205	49	539	16.5	16.5	600 V	Guide Rail
		Greece																					
45.	1925	Athens	3.0 (A)	16.0	(14.2)		13.1	0.84	50	21.8	86.0	4.0	347	135	8.1	42.8	180	56	524	23.0	2.84	600 V	3rd R.
		Hungary																					
46.	1896	Budapest (Foldalatti)	2.4 (A)	2.5	(0.4)	0.5		0.25	37.3	11.8	21.0	2.1	44	23	1.37	32.1	171	48	689	21.0	15.3	550 V	Cat.
47.	1970	Budapest (Metro)	2.4 (A)	9.2	(0.8)	9.9	33.6	0.62	50.0	21	270.6	2.17	586.3	175	11.4	51.6	171	48	689	62.4	5.47	825 V	3rd R.
		Ireland																					
48.	1990	Dublin	1.0 (A)					44.1				4.10		100			136	42	377				
		Italy																					
49.	1964	Milan	3.9 (A)	27.0	(8.4)	3.2	9.3	0.42	53.1	17-21	190.7	3.06	583.5	354	13.8	42.3	218	36	500	83.9	6.08	750 V 1500 V	3rd R. Cat.
50.	1986	Naples	3.4 (A)			6.9	9.3	0.49	50										515			1500 V	Cat.
51.	1955	Rome	3.6 (A)	15.6	(3.7)			0.68/ 0.42	62.1/ 49.7	23.2/ 20.5	35.7	3.92	139.8	208	2.5	54.8	202	32	499	22.5	9.00	1500 V	Cat.
		Netherlands																					
52.	1977	Amsterdam	0.7 (A)	7.0	(7.8)	2.5		0.56	43.5	20-22	16.0	2.92	46.7	74	1.86	25.1	150	50	581	19.3	10.4	750 V	3rd R.
53.	1968	Rotterdam	0.8 (A)	10.6	(8.6)	7.5		0.94	50.0	20.0	36.5	3.48	127.0	142	3.9	32.4	119	40	371	23.3	5.97	750 V	3rd R.
		Norway																					
54.	1966	Oslo	0.5 (C)	22.1	(15.4)	0.9		0.51	43.5	20.0	37.0	4.23	156.4	162	6.2	25.4	168	62	571	43.0	6.94	750 V	3rd R.
		Poland																					
55.	1988	Warsaw	1.3 (A)			15.2	65.6	0.66	56								170	44	523				
		Portugal																					
56.	1959	Lisbon	2.3 (A)	7.5	(0.0)	3.1	12.5	0.39	37.3	17.4	111.7	1.99	222.3	80	4.2	52.6	200	36	463	31.0	7.35	750 V	3rd R.

(Continued)

The metropolitan railways of the world: Statistical highlights

No.	Year of Initial Operation	City	Million Population	ROUTE MILES: In Operation: Total	In Operation: Above Ground	In Construction	In Design/Planning	Avge. Distance Between Stations	Speed MPH: Maximum Design	Speed MPH: Avge. Commercial	Annual Million Passengers	Avge. Trip Length	Annual Million Passenger Miles	No. of Cars	Annual Car Miles	Avge. Passengers Per Car	Passenger Capacity: Latest Cars: Total	Passenger Capacity: Latest Cars: Seated	Car Floor Area, sq. ft	Annual Million kWh for Traction	kWh Per Car Mile	Power Supply: Voltage	Power Supply: 3rd R. or Cat.
		Rumania																					
57.	1979	Bucharest	1.6 (A)	5.0	(0.0)		23.0	1.00	56.0	25.0				80			260	42	513			750 V	3rd R.
		Spain																					
58.	1924	Barcelona-Metropolitano	2.9 (A)	30.0	(0.6)	7.1	28.2	0.43	37.3	14-17	243.0	3.0	729	412	19.3	37.3	236	36	466	103.1	5.34	1500 V 1300 V	3rd R. Cat.
59.	1929	Barcelona-Sarria	2.9 (A)	4.8	(1.7)	0.6		0.40	37.3	18.6	28.8	0.9	27	34	1.2	22.5	116	56	534	11.5	9.58	1200 V	Cat.
60.	1983	Bilbao	0.9 (A)				11.2	0.66	50.0	23.0							200		542				
61.	1919	Madrid	3.5 (A)	46.0	(3.4)	3.6		0.34	40-50	14-19	394.0	3.2	1261	763	44.1	28.6	236	40	518	199.4	4.52	600 V	Cat.
62.	1983	Seville	0.9 (A)			6.5	10.3	0.44		21.8				112			200		472			1500 V	Cat.
		Sweden																					
63.	1950	Stockholm	1.5 (A)	64.4	(29.2)	3.9	3.9	0.62	56.0	20-25	189.0	4.23	798.8	885	39.8	20.1	156	48	561	206.0	5.18	650 V 750 V	3rd R. 3rd R.
		United Kingdom																					
64.	1896	Glasgow	2.5 (A)	6.5				0.44	33.6	18.0	10.0	1.9	19	33	0.65	29.2	90	36	304	4.1	6.30	600 V	3rd R.
65.	1863	London	7.0 (A)	254.0	(151.0)	3.5		0.81	68.4	20.4	594.0	4.7	2769	3994	202.0	13.7	232	48	551	618.0	3.06	600 V	3rd R.
66.	1980	Newcastle	1.3 (A)	11.7	(10.8)	21.8		0.90	50.0	28.0				58			210	84	742			1500 V	Cat.
		USSR																					
67.	1967	Baku	1.5 (C)	11.6	(1.1)	4.2	7.3	1.12	56.0	28.6	138.9	3.98	552.5	108	7.95	69.5	170	44	523	46.8	5.89	825 V	3rd R.
68.	1988	Dnepropetrovsk	1.1 (C)				8.1															825 V	3rd R.
69.	1984	Gorki	1.3 (C)			6.0	10.4	0.85														825 V	3rd R.
70.	1975	Kharkov	1.4 (C)	10.8	(0.0)	6.8	7.8	0.89	56.0	30.0	164.0	3.36	550.4	176	13.11	42.0	170	44	522	69.7	5.3	825 V	3rd R.
71.	1960	Kiev	2.1 (C)	13.5	(3.6)	8.2	7.6	0.80	56.0	28.0	242.3	4.72	1144.5	279	18.6	61.5	170	44	516	83.4	4.48	825 V	3rd R.
72.	1990	Kuhyshev	1.2 (C)				10.9															825 V	3rd R.
73.	1955	Leningrad	4.6 (C)	38.4	(0.4)	6.7	14.4	1.09	56.0	28.9	678.6	5.22	3542.7	937	77.8	45.5	170	44	521	319.1	4.10	825 V	3rd R.
74.	1983	Minsk	1.3 (C)			5.3	8.3	0.67	56								170	44	522				
75.	1935	Moscow	8.0 (C)	114.4	(11.2)	14.7	16.8	1.14	56.0	30.0	2266.2	6.09	13802.7	2675	253.3	54.4	170	44	522	1005.8	3.97	825 V	3rd R.
76.	1985	Novosibirsk	1.3 (C)			8.0	6.0	0.89	56								170	44	522			825 V	3rd R.
77.	1990	Riga	0.8 (C)				12.4																
78.	1977	Tashkent	1.7 (C)	7.0	(0.0)	2.5	5.3	0.88	56.0	29.3	58.7	3.42	200.7	75	4.85	41.4	170	44	522	32.0	6.6	825 V	3rd R.
79.	1966	Tbilisi	1.1 (C)	11.7	(1.5)	5.0		0.78	56.0	28.5	126.4	3.11	392.8	105	8.1	48.6	170	44	523	47.0	5.80	825 V	3rd R.
80.	1981	Yerevan	1.0 (C)			7.1		0.89														825 V	3rd R.

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The metropolitan railways of the world: Statistical highlights

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		MIDDLE EAST																					
		Iraq																					
81.	1986	Baghdad	2.9 (A)			7.5	18.6			22.4				186			145	49	527				
		Israel																					
82.	1990	Tel-Aviv-Jaffa	0.9 (A)				37.3	0.39	56-0					130			250	80					
		Turkey																					
83.	1988	Ankara	2.8 (A)				7.1	0.39	50	22.4				130			155	45	398				
		ASIA																					
		China																					
84.	1971	Peking	8.0 (A)	14.7	(0.0)	10.0	8.0	0.92	43.5	23.6	35.0			64			185	60	560			750 V	3rd R.
85.	1980	Tianjen	3.0 (C)	3.1	(0.0)		4.4	0.62	43.5													-	3rd R.
		Taiwan																					
86.	1988	Taipei	5.0 (A)				13.25																
		Hong Kong																					
87.	1979	Hong Kong	4.7 (A)	9.7	(3.8)		6.7	0.69	50.0	20.0	14			210			375	48	710			1500 V	Cat.
		India																					
88.	1985	Calcutta	9.0 (A)			10.2		0.64	50	18.6				72			300	46	549			675 V	3rd R.
		Japan																					
89.	1979	Fukuoka	1.0 (C)	9.2	(0.0)				56.0	25.5						-	145	-	527			600 V	Cat.
90.	1977	Kobe[a]	1.4 (C)	3.6	(1.7)	5.0		1.18	62.2	26.7	13.0			24	1.68		142	56	545			1500 V	Cat.
91.	1981	Kyoto	1.5 (C)	4.3	(0.0)	3.2	20.5	0.61	46.6	20.5							130	52	543			1500 V	Cat.
92.	1957	Nagoya	7.3 (A)	32.1	(4.4)	3.7	1.9	0.62	46.6	21.1	264.0	3.23	852.7	420	20.5	41.6	135	51	563	113.8	5.55	600 V 1500 V	3rd R. Cat.
93.	1933	Osaka	8.3 (A)	47.0	(6.5)	8.4	3.1	0.62	43.5	19-21	766.8	2.67	2049.2	770	39.4	52.0	140	48	561	181.3	4.60	750 V 1500 V	3rd R. Cat.
94.	1971	Sapporo	1.3 (C)	15.0	(2.9)	4.7	10.0	0.62	43.5	20-24	171.6 (1976)			248	8.33		121	48	570	33.3	4.0	750 V 1500 V	3rd R. Cat.
95.	1927	Tokyo (TPTA)	24.3 (A)	81.4	(13.7)	2.1	29.5	0.68	34-62	15-28	1561.0	4.5	6985	1595	96.6	72.3	144	54	581	363.7	3.77	600 V 1500 V	3rd R. Cat.
96.	1960	Tokyo (TBIMG)	24.3 (A)	34.1	(3.9)	4.5	24.2	0.60	46.6	19.2	301.0	3.80	1141.1	440	25.2	45.3	160	54	536	124.1	4.92	1500 V	Cat.
97.	1972	Yokohama	2.6 (C)	7.1	(0.0)	5.3	31.3	0.71	56.0								145	52	538			750 V	3rd R.
		Korea Republic																					
98.	1974	Seoul	7.9 (A)	5.9	(0.0)	8.7	21.8	0.61	50.0	21.8	255.5											1500 V	Cat.
		Australia																					
99.	1926	Sydney	3.0 (A)	5.7	1.7			1.36	37-62		177			191	9.4		248	114	749				

(A) Area Population (C) City Limit Population

Market

CARLOADINGS

Loadings of revenue freight in the week ended Sept. 5 totaled 450,161 cars, according to the Association of American Railroads. This was an increase of 62,459 cars, or 16.1%, compared with the corresponding week last year. Ton-miles generated by carloadings in the week ended Sept. 5 are estimated at 19.4 billion, an increase of 21.1% above the corresponding week of 1980. The 1980 week included the Labor Day holiday.

REVENUE FREIGHT CARLOADINGS

Commodity	Sept. 5 week	Aug. 29 week
Grain	29,102	27,208
Other farm products	2,705	3,125
Metallic ores	36,376	36,190
Coal	135,197	139,877
Crushed stone, gravel & sand	12,422	13,012
Nonmetallic minerals	12,736	13,611
Grain mill products	13,982	14,218
Food & kindred products	15,896	15,843
Primary forest products	17,301	18,938
Lumber & wood products (except furniture)	6,961	7,585
Pulp, paper & allied products	19,868	19,327
Chemicals & allied products	26,420	26,393
Petroleum products	5,295	5,338
Stone, clay & glass products	13,572	13,280
Coke	6,750	6,935
Metals & products	16,236	15,506
Motor vehicles & equipment	12,797	12,945
Waste & scrap materials	11,817	11,832
Forwarder & shipper assn. traffic	10,022	10,040
All other carloads	44,517	45,154
LCL traffic	219	256
Total cars loaded	**450,161**	**456,613**
Cumulative total	1981	1980
36 weeks	**15,066,511**	**15,588,303**
Estimated revenue ton-miles (billions), 36 weeks	**639.1**	**629.1**

PIGGYBACK LOADINGS

U.S. piggyback loadings for the week ended Aug. 29 totaled 34,576 cars (3.7% above the corresponding 1980 week) and 64,417 trailers or containers (up 5.3% from 1980). Cumulative volume for the first 35 weeks of 1981 is 1,135,382 (up 1.4% from 1980) and 2,052,275 trailers or containers (up 0.6% from 1980).

CANADIAN CARLOADINGS

Canadian railway revenue freight loaded in the seven-day period ended Aug. 14 totaled 4.4 million tons (down 11.4% from 1980). Cars loaded totaled 61,733 (down 12.8% from 1980). Cumulative loadings for 1981 were up to 158.8 million tons (down 3.1% from 1980).

● *Conrail.*—An $8.6-million upgrading of 47½ miles of line between Kankakee and Streator, Ill., calls for installation of cwr, surfacing, improvement of 17 switches, and resurfacing of 64 grade crossings.

● *Chattahoochee Industrial Railroad.*—Is leasing 200 new 70-ton boxcars, valued at $9 million, from the Railcar Division of Evans Products Co.'s Transportation Systems and Industrial Group. The cars will be assigned primarily to CIRR's largest on-line customer, Great Southern Paper Co.

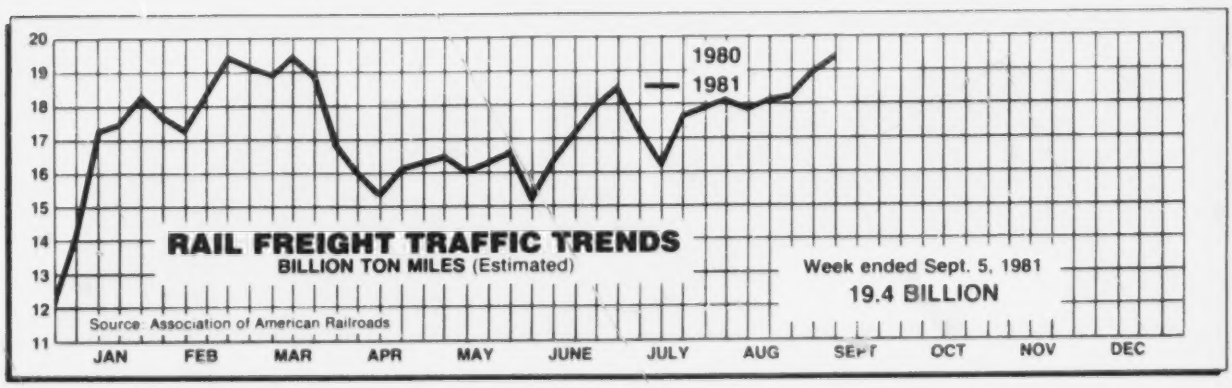
● *Iraq Republic Railway Organization.*—Placed a $17.5-million order with the Rail and Diesel Products Division of Bombardier for the supply of spare parts for Bombardier-built diesel-electrics.

● *Niagara Frontier Transportation Authority.*—The 33 light rail vehicles that Tokyu Car of Yokohama is building for NFTA's Buffalo, N.Y., system will have propulsion controls, motors, and gear units supplied by Westinghouse Electric, according to a letter of intent awarded by Mitsui and Company USA, agents for the Japanese firm. The chopper control propulsion systems will utilize fourth generation Westinghouse microprocessor technology.

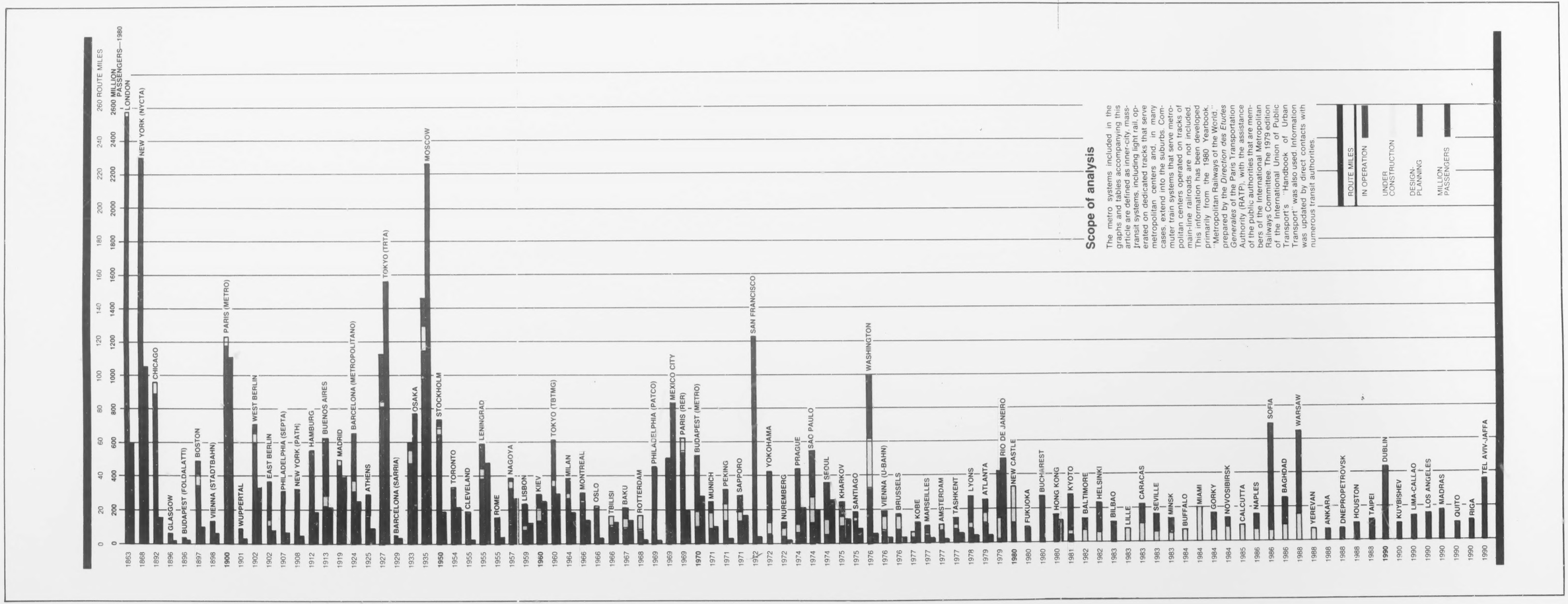
● *Portland Tri-county Metropolitan Transportation District.*—Awarded a $25-million (Canadian) contract to Bombardier, Inc. to supply 26 six-axle, articulated, double-end light rail cars (*RA*, Aug. 10, p. 32).

● *Southern California Rapid Transit District.*—Has selected Booz Allen & Hamilton to provide systems engineering and analysis support during the preliminary engineering phase of SCRTD's proposed Metro Rail Project.

● *Washington Metropolitan Area Transit Authority.*—General Railway Signal is the apparent low bidder, at $3.9 million, for supply and installation of a signal and control system at Shady Grove Yard, which will be located at the end of WMATA's Red Line in Maryland. GRS President Gerald E. Collins said equipment production is to begin at Rochester, N.Y., later this year; the project is due for completion in August 1983.



The metropolitan railways of the world: A chronology



Scope of analysis

The metro systems included in the graphs and tables accompanying this article are defined as inner-city, mass-transit systems, including light rail, operated on dedicated tracks that serve metropolitan centers and, in many cases, extend into the suburbs. Commuter train systems that serve metropolitan centers operated on tracks of main-line railroads are not included. This information has been developed primarily from the 1980 yearbook, "Metropolitan Railways of the World," prepared by the *Direction des Etudes Generales* of the Paris Transportation Authority (RATP), with the assistance of the public authorities that are members of the International Metropolitan Railways Committee. The 1979 edition of the International Union of Public Transport's "Handbook of Urban Transport" was also used. Information was updated by direct contacts with numerous transit authorities.